AirCRED Users' Guide

An instructional handbook for the
Air Emissions Reduction Credits Calculator (AirCRED)
[a Microsoft Windows95/98/NT/2000 WWWeb Application]

DRAFT

Developed by Argonne National Laboratory
Code Developed by Chris Saricks and Michael Vogt

This document is one part of a documentation set that includes
a Users' Guide, a Programmers' Manual, and a Project Technical Report

AirCRED Documentation Set

The AirCRED documentation set is divided up into three parts, each focusing different users' needs.

AirCRED Users' Guide: This is the stripped-down step-by-step guide describing where and how to get a copy of the AirCRED application, how to launch it, and how to interact with it to generate credit numbers.

AirCRED Programmers' Manual: This details the development of the internal AirCRED calculation models and their deployment as both a stand-alone Microsoft VisualBASIC application and as a Internet WWWeb-based application. It is intended to provide explanation of the theory of operation and the direction's for AirCRED's future development and use.

AirCRED Project Technical Report: This describes the AirCRED project, the sponsor's needs, the history of the development, and the group supporting AirCRED.

Background

To assist the Department of Energy's (DOE's) Clean Cities coalitions in estimating the ozone precursor emissions reduction credits earned by acquiring original equipment manufacture (OEM) alternative-fueled vehicles (AFVs), Argonne National Laboratory (ANL) has developed a graphical-user-interfaced credit-calculation model called *AirCRED* (a working title subject to possible change prior to its release). ANL's goal was to provide an easy and straightforward manner for the values of those credits to be summed together with Voluntary Mobile Source Emission Reduction Program (VMEP) credits due to other local voluntary strategies and programs earned pursuant to EPA's October 1997 guidance.

AirCRED is based on the Environmental Protection Agency's (EPA's) MOBILE5b model combined with emission test certification data for new OEM vehicles and their gasoline- or diesel-fueled counterparts. It starts with the MOBILE5b-computed emission factor (by vehicle type) appropriate to midsummer, ozone-season conditions in each Clean City (about 60 different values are available). The "clean gap" between AFV and conventional counterpart emissions of NMHC, CO, and NO_X determines the magnitude of the net grams/mile (g/mi.) credit that can be taken for AFV driving in each Clean City, relative to MOBILE5b's emission rates. In the case of LDVs, credit is based on both the entire chassis dynamometer-based Federal Test Procedure and bag 1 [cold start] of the test only. For HDDVs (transit and school buses and medium-heavy trucks operating on natural gas), it derives from engine dynamometer certification data and thus does not include any cold start computation.

A Brief Description of AirCRED's Operation

After the Clean City of interest has been selected from a list menu, *AirCRED* prompts the user for

a) the number of, respectively, AFV cars, trucks and buses acquired in that consortium area during a one-year period, by fuel type;

b) the average miles per day driven by each of these categories;

c) the number of days driven per week by each of these categories; and

d) the percentage of miles driven daily by each AFV on non-petroleum fuel.

If cold-start credits also are sought for light-duty AFVs replacing gasoline-powered units, *AirCRED* prompts for

a) the fraction of daily regional VMT taking place between 6:30 and 9 a.m., and

b) if the vehicles in each category are turned off for one hour or more at lunch time.

There are two results screens, one showing current-year 24-hour (FTP) credits and the other (optional) showing cold-start credits and *total* FTP/MOBILE5b credits for the current year. The total set adds in residual credits for AFVs acquired after 1997 that are still in service and incorporates emission deterioration rates where applicable. For the 24-hour credits, the total mass attributable to each AFV type in the local fleet is shown. Results are reported in tons per day and pounds per day; it is the user's responsibility to then multiply this value by the number of days in the ozone season to take the appropriate annual credit. A multiplier equal to the number of days in the year is inappropriate because the emission factors applied reflect only warm season conditions.

Implementation of AirCRED

There are two different packages available for AirCRED: a stand-alone one and a WWWeb based one.

The stand-alone AirCRED v1.3 runs on a Microsoft Windows95/98/NT/2000 operating system and requires 3093kB of storage space for the installer module. The software employs a common WinZip file to download the installer to the host machine. This zipped installer is available on the AirCRED web page – "http://appserver.es.anl.gov/aircred.html", along with an adobe.pdf version of this documentation. The zipped installer is transferred to the host machine, and placed in a TEMP directory. The zip file is extracted and the installer launched. The installer will copy required .dll files and the AirCRED software will be set up with a routine Program Group and Application entry. After successful installation, AirCREDv1.3 can be launched via the Windows Start menu.

The other package for AirCRED is a WWWeb-based application that can be launched and run from either Microsoft Explorer [4+] or Netscape Navigator [4+] browsers. This version is available over the Internet from the AirCRED home page and can be accessed by pointing the appropriate browser at: http://appserver.es.anl.gov/aircred.html. Additional DOE and EPA websites will also make available links to the AirCRED home page in the near future as the initial project is completed and a permanent home for AirCRED is established.

How Clean Cities Coalitions Should Use this Model

AirCRED is intended to open the door for coordinators and stakeholders from DOE's Clean Cities program to work more closely with state and regional air quality planners and officials who are laying the groundwork for revising and updating ozone precursor emission reduction strategies under new ozone SIP

calls. The former will better appreciate how--and to what actual degree--their AFV acquisitions under EPACT-related programs contribute to cleaner air, just as the latter can benefit from the numerical estimates that AirCRED provides them in summing up the emission benefits of their complete VMEP package for current and future years. Once AirCRED becomes an EPA-accepted and approved tool, the values generated by the model can be submitted directly to air agencies and will obviate their having to devote extra time and effort to analyzing AFV credits. There will also be a uniform basis across all EPA regions for accepting (or rejecting) those credits.

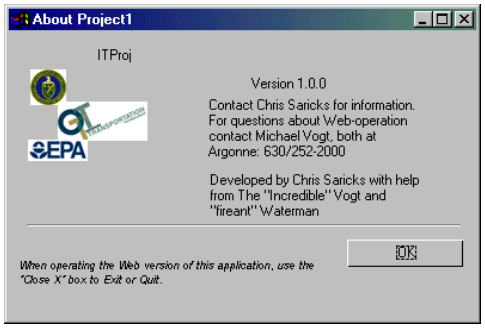
Current and Future Internal Model Implementation

AirCRED (as MOD1) currently computes actual credits for electric vehicles and for dedicated and dual-fueled natural gas LDVs, LDTs, and HDVs (i.e., transit buses and medium heavy duty natural gas vehicles replacing diesel-fueled school buses and Class 5 through 7 trucks) through the year 2000 ozone season. In its final implementation (MOD2, to be developed during FY01), it will add Class 8a and 8b local service vehicles and truck tractors as well as both propane and alcohol dedicated and dual (flex)-fueled vehicles and provide 24-hour and cold start credits through at least 2004, for existing vehicles. Addition of credits against Tier2-certified gasoline and diesel vehicles using MOBILE6 emission rates is also being considered. The model will be updated regularly (at least annually) as new certification data for AFVs are obtained.

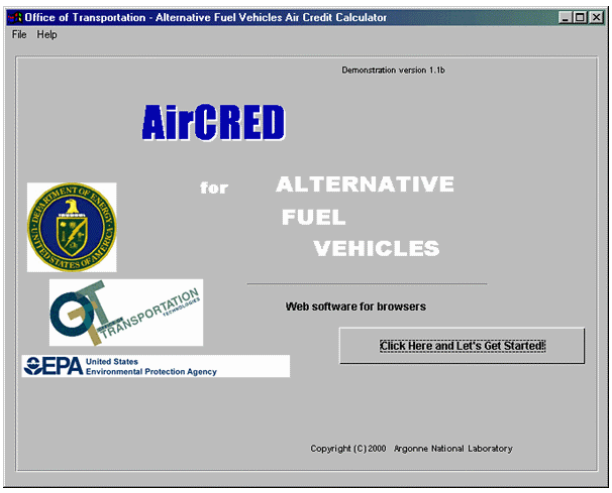
AirCRED Screen-by-Screen Presentation and Data Entry

It is hoped that this guide's language and descriptions of the model procedure accord with both the intended "user-friendliness" of the model and the position that EPA has taken on assigning legitimate emission reduction credits to AFVs under VMEP.

AirCRED is written in VisualBASIC for Microsoft Windows95/98/NT/2000™, a software package developed around the concept of presenting screens or forms to a user as a way of eliciting data input and providing output information based on that data. The user is allowed to select multiple options through clicking on "radio-button" controls from each screen. AirCRED has been designed to lead the user through a logical sequence of data entry using a mouse and keyboard; it permits returning to any data input screen if a user discovers that he or she has made errors in data entry or wants to change the values of certain parameters. It seeks to be "user-friendly" in the sense that the user is informed in a straightforward manner what to do on each screen and at the end of the process provided a clearly understandable result. It is not "rocket science," just a handy tool for busy people.

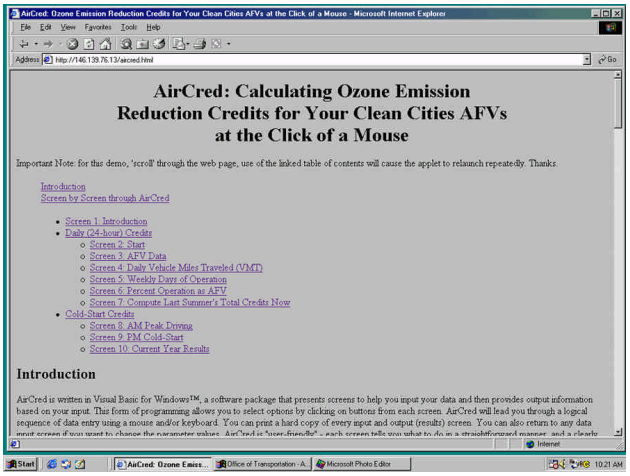


AirCRED's introduction screen [**Screen 1**] shows a few of the light-duty AFV models that are currently available and introduces the user to the fact that the mouse-click mode of data entry will be used during the walk through the procedure. Later screens are intentionally color-coded to help navigate the interface and coordinate operation with the associated Users' Guide.

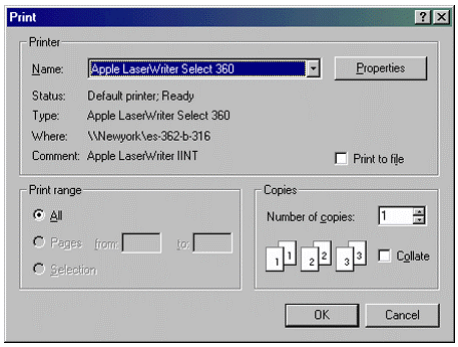


AirCRED was developed with funding support from the U.S. DOE, Office of Transportation Technologies, and EPA Office of Transportation and Air Quality.

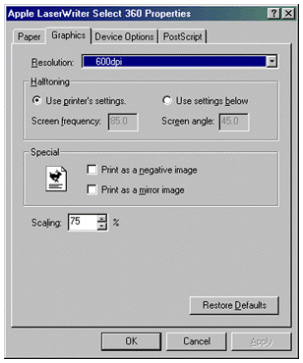
The web version of AirCRED is launched from a typical html page that provides side-by-side instruction as the user walks through the application. The contents of the accompanying web page should be viewed as the latest release as changes there will be most easily made. If a user's monitor is large enough, both the web page instructions and the applet (application) can be view together side-by-side promoting the easiest interaction.

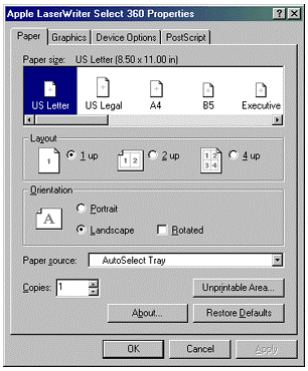


Most users will require a printed version of their step-by-step results. A "Print" button is available on most data input screens and a "Print" option is available via the menus on non-data entry screens.

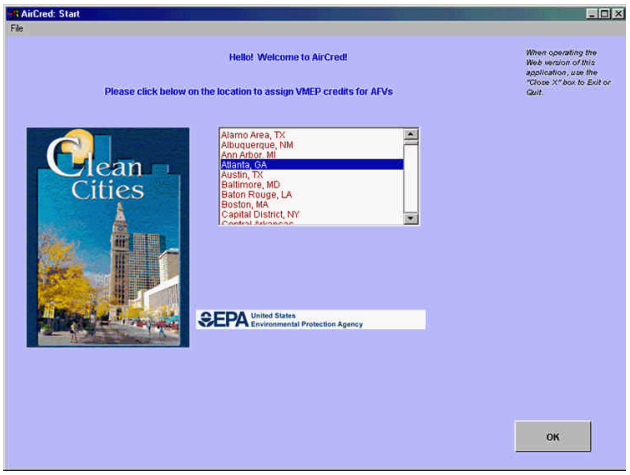


Printing is best accomplished by setting up the user's default printer prior to launching AirCRED. The following dialog boxes illustrate the typical best settings that use landscape orientation and an approximate 25% reduction in size [to 75%] to allow even the largest data entry screen to be printed on one page. When these changes are made to the system's default printer, all theuser needs to do is press the "Print Form" buttons to generate documentation pages.

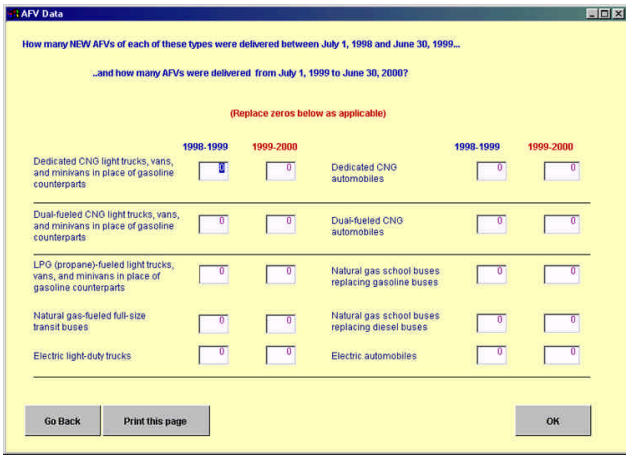




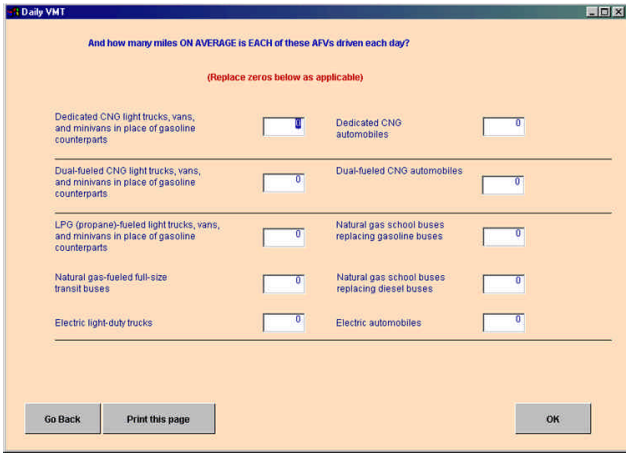
AirCRED Start [Screen 2] prompts the user to select the desired Clean City from the scroll-down list at the center of the image. All Clean Cities (designated as of July 2000) are on the list, but the model currently works only for Clean Cities in those states that use the MOBILE model to estimated vehicular emissions (i.e., the 49 states outside California). As now implemented, if a California location is selected from the list, a screen appears with the California disclaimer and the model terminates execution.



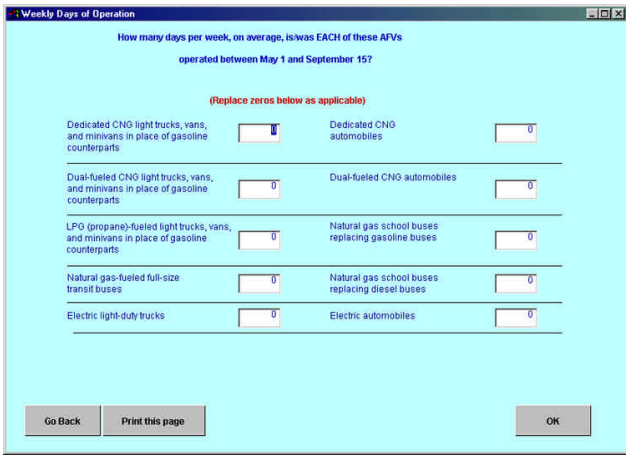
AFV Data [Screen 3] prompts the user to key into the appropriate text block the count of AFVs of a particular type *delivered* during 1998 and 1999. Ten fuel/vehicle combinations -- four light trucks, three bus types (one of which includes MHDD replacement vehicles), and three automobiles -- currently comprise the selection menu. This and all subsequent data entry and display screens provide a click option to return to any prior screen in order to revise inputs. Data entry boxes for each AFV type are in the same position on every screen.



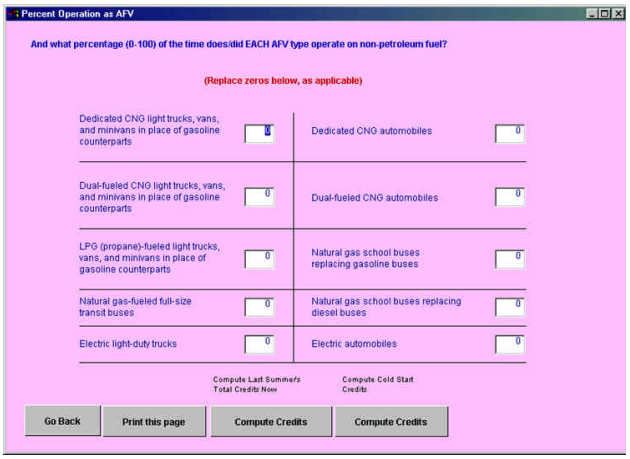
Daily VMT [Screen 4] prompts the user to key into the appropriate text block the average daily miles driven by each AFV type acquired. Values left at zero remove a vehicle type from further credit calculation.



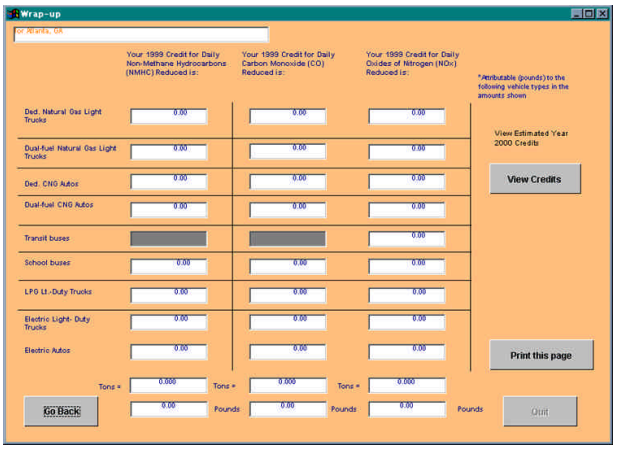
Weekly Days of Operation [Screen 5] prompts the user to key into the appropriate text block the number of days per week that a vehicle is in service. Values left at zero remove a vehicle type from further credit calculation. Vehicles in service more than the five normal weekly workdays earn extra credit.



Percent Operation as AFV [Screen 6] prompts the user to enter, in the appropriate text block, the percent of VMT (0-100) that each vehcile accomplishes on a non-petroeum fuel. All dedicated-fuel AFVs are assumed to be part of centrally-refueled fleets.

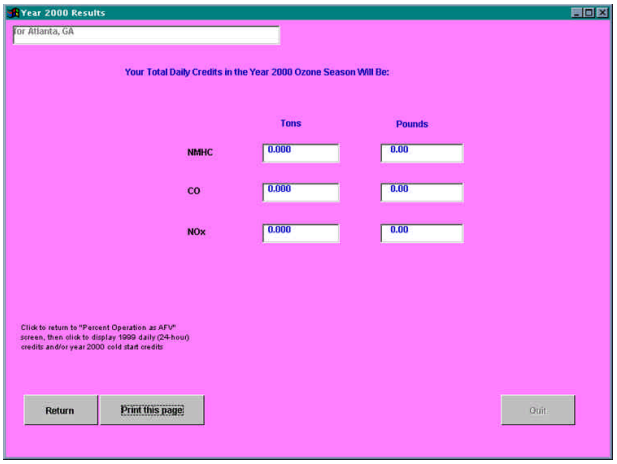


Wrap-Up [Screen 7] is the first screen resulting from a "branching" option. If this screen ("Compute Total Credits Now") is selected from the central refueling screen choice menu, it returns the Clean City selected and the cumulative total (FTP-based) daily credits, for the preceeding summer, in (short) tons and pounds of NMHC, CO, and NOx for all AFVs entered. It also gives a credit breakdown (in pounds) by vehicle type. From this screen, the user is asked if credits for the current year and/or cold start credits should also be displayed. If the cold start option is selected, the user is passed to screen 8a.

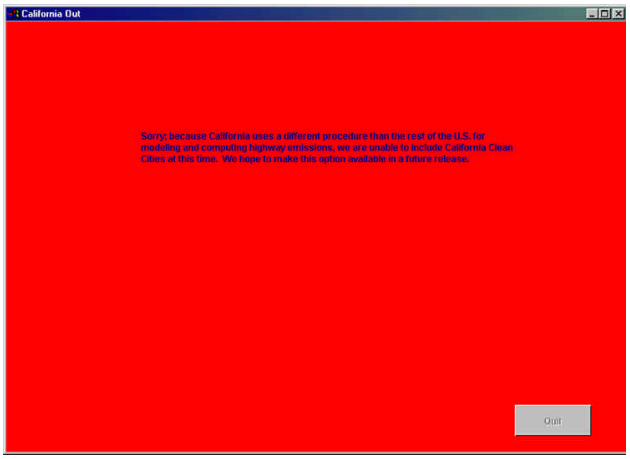


Year 2000 Results [Screen 10] shows cumulative (through year 2000) total credits for each of the three precursor pollutants in pounds and tons. From this screen, the user may terminate the program or, if not yet seen, get total prior-year credits from Screen 7 (returning via screen 6).

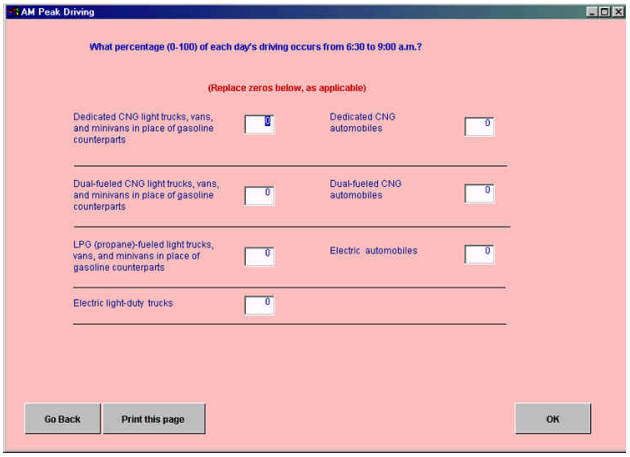
[Screens 11] through **[Screen 14]** mimic Screen 10 by providing estimated credits for 2002, 2003, 2004, and 2005, respectively. Only the 2005 screen does not provide the click option for credits into the future, as it is believed that most light-duty AFVs acquired prior to the 2000 ozone season (the only vehicle types for which daily credits will actually change due to control programs such as I/M, NLEV, and Phase 2 RFG) will be at or near retirement from their respective fleets by the end of 2005.



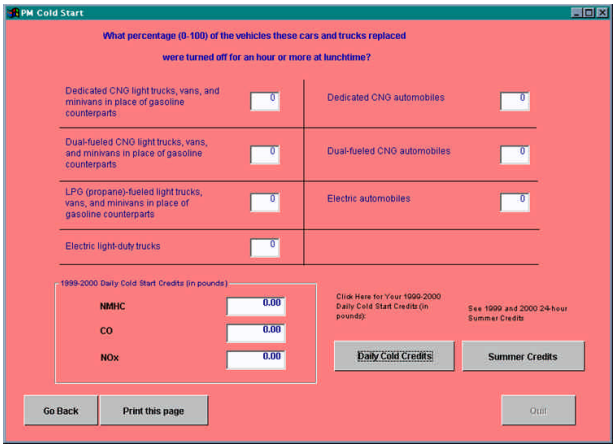
California Out [Screen 11] informs the user that California is not included in this credit calculation because that state uses different emissions calculation procedures.



AM Peak Driving [Screen 8] is invoked from either Screen 6 (if cold credit calculations are selected from that screen) or Screen 7 (if the user wants to see future year and cold start credits AFTER viewing 24-hour credits). It prompts the user for the fraction of daily vehicle miles in the selected Clean City metro area that occurs between 6:30 and 9 a.m. on weekdays. Most larger urban areas have reliable estimates of this value available. The screen presumes that the AFVs' first engine start of the day occurs during this period. Data entry to a second cold-start-related screen, 8b, is also required because of the importance of NMHC emission reductions during prime ozone-forming hours (generally before 3 p.m.). Screen 8b assigns an extra cold start reduction credit to any AFV that replaced a vehicle turned off at lunchtime for an hour or more. Credit should not be taken if the conventional (predecessor) vehicles remained in continuous service throughout the day.



PM Cold-Start [Screen 9] assigns extra cold-start reduction credits to any AFV that replaced a vehicle turned off at lunchtime for an hour or more. Credit should not be taken if the conventional (predecessor) vehicles remained in continuous service throughout the day. For each vehicle type you entered on Screens 3 through 6 that is shown here (heavy-duty diesel- replacement vehicles do not qualify for cold-start credits), enter the percentage of vehicles in this category that meet the lunchtime engine-off criterion - a value between 0 and 100.



At any time during the operation users can backtrack their steps and make changes and corrections before proceeding. Each form can be printed to provide the necessary documentation trail. To complete a session the user can simply press the Quit button [on the stand-alone application] or they can press the Close button [] at the top right of any given data entry screen [on either version]. To re-launch the web-based version of AirCRED just press the F5 (refresh) key in the browser interface.

ANL strongly recommends using the web-based version of AirCRED as it will be maintained more efficiently and does not require installation of code on the user's machine if they are running the appropriate versions of the browsers.

References

1. Wang, M. *GREET 1.5—Transportation Fuel-Cycle Model, Volume 1: Development and Use;* Argonne National Laboratory, Argonne, IL, August 1999.

2. Kremer, J., "Modeling Emission Factors for Compresed Natural Gas Vehicles," *EPA420-P-99-02*, Office of Mobile Sources, U.S. EPA, Ann Arbor, MI, April 1999.

3. Duggal, V., Cummins Engine Co., Columbus, IN, personal communication, September 3, 1999.

4. Clarke, J.L., *Natural Gas Vehicle Coalition*, Arlington, VA, personal communication, September 24, 1999

5. Browning, L., "Update Heavy-Duty Engine Emission Conversion Factors for MOBILE6: Analysis of BSFCs and Calculation of Heavy-Duty Engine Emission Conversion Factors," *EPA420-P-98-015*, for Office of Mobile Sources, U.S. EPA, Ann Arbor, MI, May 1998.

Appendices

EPA Interest and a List of Clean Cities

Of most interest to EPA will be the numerical basis of the initial credits for each Clean City. Table 1 shows the complete list of Clean Cities and the 1999 AND 2000 values of their respective FTP-based MOBILE5b baseline emission factors (for LDGVs and LDGTs) for (a) the entire FUDS and (b) Bag 1 only, together with the emission control program assumptions for each Clean City. Appendix B contains a selection (three Clean Cities) of the (formatted) MOBILE5b run outputs showing the complete set of local ozone season parameter values (e.g., temperature rise, altitude) used to generate the baseline factors for 1999 through 2004. MOBILE5b's sensitivity to most of these parameters was such that, within similar regimes of temperature rise and ozone season control programs, there is not much variation among emission factor values by pollutant (and none whatever for heavy-duty diesel NOx factors, which are insensitive to temperature and cold start effects). While it is true that city-to-city variation in average travel speed may exist but is not reflected in these values, it is also true that credits taken by using differences in EPA emission certification results should apply to emission certification *driving* conditions (i.e., the FUDS) as reproduced by each run's MOBILE5B inputs.

A Listing of the Clean Cities (CC) Currently Included in *AirCRED* (California Cities Not Yet Operationalized).

Clean Cities			
Albuquerque, NM	Ann Arbor, MI	Atlanta, GA	Austin, TX
Alamo Area.TX	Baton Rouge, LA	Capital District, NY	Central Arkansas
Baltimore, MD	Boston, MA	Central Oklahoma	Chicago, IL
Central Indiana Alliance	Central NY	Coachella Valley, CA	Colorado Springs, CO
Cincinnati, OH	Cleveland, OH	Dallas/Ft. Worth, TX	Delaware (entire state)
Connecticut Capital	Corpus Christi, TX	Evansville, IN	Florida Gold Coast
Denver, CO	Detroit/Toronto, MI-ON	Hampton Roads., VA	Honolulu, HI
Florida Space Coast	Genesee Region, NY	Lancaster, CA	Las Vegas, NM
Houston, TX	Kansas City, MO	Los Angeles, CA	Louisville, KY
Long Beach, CA	Long Island, NY	New Haven. CT	North Jersey, NJ
Manhattan, KS	Missoula, MT	New London, CT	Peoria, IL
Norwich, CT	Omaha, NE	Paso Del Norte, TX	Portland, ME
Philadelphia, PA	Phoenix, AZ	Pittsburgh, PA	Red R. Valley, ND-MB
Portland, OR	Providence, RI	Puget Sound, WA	Salt Lake City, UT
Rogue Valley, OR	Sacramento, CA	St. Louis, MO	SCAG (CA)
San Diego, CA	San Francisco Bay, CA	San Joaquin, CA	Tucson, AZ
South Shore, IL	Southwestern CT	Southwest Kansas	Weld-Larimer-RMNP, CO
Tulsa, OK	Washington, DC	Waterbury, CT	Wisconsin SE area
Western NY	W. Virginia (entire state)	White Plains, NY	

Initialization of MOBILE5b Credit Base

City-specific values generated by MOBILE5b [se example at end of this appendix] provide the starting point for alternative fuel-specific credits (NOTE: For the NMHC credit baseline, refueling emission losses are added to the cumulative total for exhaust and evaporative emissions reported in MOBILE5b output). In the case of natural gas-fueled vehicles, a pollutant-specific average of the (full FTP and Bag 1-only) certification data ratios between the AFVs and their gasoline-fueled counterparts is computed based on production shares for the CNG make/model combinations available as OEM offerings for MY1998 and MY1999 (overall sales data are not yet available, especially for MY1999 offerings). Weighted averages by NG/gasoline counterpart vehicle offering were computed by applying the following fractions to certification results (common to 1998 and 1999 MY):

LDV: 0.35 x Ford Crown Victoria + 0.25 x Ford Contour + 0.25 x Chevrolet Cavalier + 0.15 x Honda Civic

LDT: 0.2 x Ford F-250 + 0.2 x Ford Econoline E-350 + 0.25 x Chevrolet C2500 + 0.35 x Dodge Ram Van/Caravan/Chrysler Minivan

Each of the 6 values (3 pollutants x 2 NG-fueled light-duty vehicle types) was subtracted from one to yield the fractional multiplier of the baseline rate that is used to compute the actual credit. Thus, if the weighted mean ratio for a given vehicle/pollutant combination is 0.3, the g/mi credit = 0.7 times the corresponding MOBILE5b composite (50/50) gasoline emission rate for 1998 and 1999 new vehicles of that combination. Table 2 shows the credit multipliers applied by vehicle type and pollutant for 24-hour and Bag 1 (see below) credits, respectively. In addition, it is assumed that 50% of refueling for both centralized and non-centralized fleets is provided by natural gas-powered compressors, with the balance by electrical compressors. Because of the on-site (in-basin) NOx emissions associated with NG-powered compression, *AirCRED* subtracts one half of the vehicle type-specific NOx emission rate in g/mi for NG compressors, used by ANL's GREET model [1], from the NOx credit assigned to each of the six NG-fueled vehicle types. In the case of NG-powered automobiles, this effectively zeroes out the daily NOx credit.

Table 2. 24-Hour FTP and Bag 1 Emission Certification Ratio Multipliers for Light-Duty Natural Gas AFVs

VEHICLE TYPE/ POLLUTANT	LDV NMHC	LDV CO	LDV NOx	LDT NMHC	LDT CO	LDT NOx
24-Hour	0.79	0.41	0.05	0.86	0.42	0.27
Bag 1 (Cold) Only	0.86	0.66	0.18	0.93	0.64	0.58

In the case of EVs, 100% of the MOBILE5b factor value is initially applied because EVs are zero-emission at the tailpipe relative to their gasoline counterparts (LDGT1 emission rates are used for EV light truck comparisons). However, for 24-hour credits, there is a "give-back" of up to 0.065 g/mi for CO and NOx emission based on "in-basin" power plant generation. One of two "give-back" values for LDV and LDT, respectively, is applied for each of the two pollutants: a representative emission rate for northeastern power plant fuel mix, and a value representative of the fuel mix for the rest of the nation (outside California). All electricity-generation values expressed as per-mile emission rates are derived from GREET. It is the resulting MOBILE5b-based values that are carried forward in subsequent computations that apply vehicle counts, miles and days driven, and central-refueling proportions.

A similar approach is used for the daily cold start (only) credits computed from data inputs to screens 8a and 8b, except that the NG-compressor and electric generation emissions penalties are not taken. For these calculations, the user must provide the proportion of daily travel accomplished by each vehicle type in the 6:30 to 9:30 a.m. period, and also indicate what fraction of the vehicles replaced by these AFVs made a one-hour lunch stop (which would mean that more than one early-day cold start, on average, was displaced). Replacement of a second cold start is awarded a one-sixth credit, and the sum of this one sixth plus the fraction of driving in the a.m. hours yields the combined fractional multiplier for the Bag 1 credit. In some cases, this value is *greater than the 24-hour value*, which is legitimate because some AFVs show emissions performance in hot stabilized and/or hot transient operation no better or even significantly worse than that of their gasoline-fueled counterparts.

Estimation of 49-State Heavy Duty Credits

It was ANL's aim, insofar as possible, to make the procedure for computing credits for heavy-duty (>8,500 lb. GVW) AFV acquisition parallel to that for LDVs. This capability is limited on two fronts: (1) the use of engine certification (only) for heavy-duty families according to intended application (e.g., medium-duty truck, urban bus) over a load cycle that does not include a cold transient, in contrast to the chassis dynamometer test with a separate cold transient bag for LDVs; and (2) the non-separation of NMHC from total HC in reporting of HDV certification test results. In search of guidance about how best to handle these discrepancies, ANL turned to the EPA documentation of its intended treatment of natural gas-fueled vehicles in MOBILE6 [2]. In that report, EPA indicates that MOBILE6 will assign no emission reduction credit for CO or hydrocarbons to natural gas HDVs that replace or are obtained in lieu of diesel-fueled units (Sec. 5.1). Moreover, all modifying factors relating to accessory load, deterioration, and power transient would be applied equally to natural gas AFVs and their respective counterparts (thus, in the case of LDVs, these factors for natural gas would be equivalent to those for ULEV-certified gasoline-fueled units—Sec. 6.2). Based on these statements, ANL currently estimates NOx credits only (where actual and legitimate, based on the *complete* heavy-duty certification cycle) and no cold start credits for replacement of diesel-powered transit and school buses (and medium heavy-duty service vehicles) by natural gas-fueled units. There is, however, a placeholder for replacement of gasoline-fueled school buses for which no model calculations occur at present.

The intended use of the natural gas-fueled HDV engine determines its baseline factor computation. All certification data for 1998 and 1999 OEM NG- and propane-fueled HDVs were obtained from the EPA certification data base posted on the Internet. Certification results for natural gas were compared within target vehicle type with their diesel-fueled counterparts. That is, all engines were compression-ignition. For 1998 and 1999, only the Cummins Engine Company and Detroit Diesel Corporation offered both natural gas and diesel versions of the same (displacement) engine. John Deere offered an 8.1-liter natural gas engine for buses and MHDTs, but no diesel counterpart. Other diesel manufacturers--Navistar, Caterpillar, Mack--did not offer *federally*-certified on-road propulsion plants fueled by natural gas; however, a Caterpillar pilot-injection natural gas engine was available for transit buses and medium heavy-duty engines (smaller displacement) in California under CARB certification in 1999. We assumed that this latter engine was also available nationally by 1999. Market share information on the qualifying (counterpart) natural gas engines was obtained from corporate sources [3, 4] and was the basis for the following weighting across certification results:

1998: Transit bus—0.4 x Cummins 8.3L + 0.4 x Cummins 10L + 0.2 x DDC 8.5L
School bus/MHDD—0.5 x Cummins 5.9L + 0.5 x Cummins 8.3 L

1999: Transit bus—0.53 x Cummins 8.3L + 0.07 x Cummins 10.L + 0.1 x DDC 8.5L + 0.2 x DDC 12.7L + 0.1 x Caterpillar 12.0L (California PING)
School bus/MHDD—0.4 x Cummins 5.9L + 0.5 x Cummins 8.3 L + 0.1 Caterpillar 7.1L (California PING)

Combined results for 1998/99 and 1999/2000 certifications were weighted 70%/30%, respectively, as the multiplier the MOBILE5b factor, which is identical for 1999 and 2000 (virtually all 1998 offerings were also available in 1999 and 2000, at equivalent certification value). Certification results for NOx in g/bhp-h were transformed to g/mi estimates based on EPA-recommended conversions by (target) vehicle type [5], and adjusted for onsite NG compression as described above. While this retained the proportionate relationship between results for diesel and natural gas counterparts, it augmented the gap between the

absolute values of the baseline emission rate difference, and it is these values which are used as the 24-hour NOx credit for natural gas replacement of diesel by the *AirCRED* procedure. They are

for transit buses: 4.679 bhp-hr/mi

for diesel-fueled school buses and medium heavy duty service vehicles: 2.989 bhp-hr/mi

These values are identical for 1998 and 1999 because certification test results for all 1998 offerings remained the same for 1999, except that Cummins no longer offers a diesel fuel option on its 10-liter (611 CID) transit bus engine (ref. 3).

Both ANL and the diesel engine manufacturers expect that the NOx gap between natural gas and diesel-powered counterparts will close almost completely by 2004, thanks to significant improvement in diesel emission control technology. [3] By that point, however, it will be useful to examine discrepancies between corresponding certification test results for fine particle emissions.

Sample MOBILE5b OUTPUTS for 24-HOUR CREDITS

```
CHISTLOUIE INDY                              Minimum Temp:  65. (F)         Maximum Temp:  85. (F)
                     Period 1 RVP:  8.1      Period 2 RVP:  6.8        Period 2 Start Yr: 2000
1   CHI_ST.LOU_INDY
 MOBILE5b (14-Sep-96)
0User supplied veh registration distributions.
0Cal. Year: 1999        I/M Program: Yes       Ambient Temp: 80.4 / 80.4 / 80.4 (F) Region: Low
                Anti-tam. Program: Yes     Operating Mode: 20.6 / 27.3 / 20.6   Altitude:  500. Ft.
                 Reformulated Gas: Yes         ASTM Class: A
0  Veh. Type:      LDGV     LDGT1     LDGT2      LDGT      HDGV      LDDV      LDDT      HDDV      MC      All Veh
+                 ______   ______    ______    _______   _______   _______   _______   _______   _____    _______
 Veh. Speeds:     19.6      19.6      19.6                19.6      19.6      19.6      19.6      19.6
     VMT Mix:      0.601     0.197     0.078               0.041     0.001     0.002     0.074     0.006
0Composite Emission Factors (Gm/Mile)
 Non-Meth HC:      0.29      0.29      0.38      0.31      1.04      0.31      0.46      2.03      2.56     0.468
 Exhaust  HC:      0.18      0.19      0.28      0.22      0.80      0.31      0.46      2.03      1.06     0.356
 Evaporat HC:      0.04      0.04      0.04      0.04      0.17                                    1.23     0.049
 Refuel L HC:      0.05      0.18      0.19      0.18      0.29                                             0.093
 Runing L HC:      0.06      0.05      0.05      0.05      0.06                                             0.050
 Rsting L HC:      0.01      0.01      0.01      0.01      0.01                                    0.27     0.012
 Exhaust  CO:      2.24      2.54      4.04      2.97     10.12      1.19      1.38      9.87     16.34     3.407
 Exhaust NOX:      0.24      0.32      0.51      0.38      2.95      0.90      1.07      7.55      0.80     0.933
0Evaporative Emissions by Component                  Weathered RVP:  7.0              Hot Soak Temp: 81.7 (F)
 (Hot Soak: g/trip, Diurnals: g, Crankcase: g/mi, Refuel: g/gal, Resting: g/hr)       Running Loss Temp: 82.4 (F)
                                                                                     Resting Loss Temp: 75.5 (F)
 Hot Soak          0.24      0.24      0.24      0.24      0.77                                    7.75
 WtDiurnal         0.53      0.57      0.58      0.58      3.17                                    5.61
 Multiple          1.67      1.67      1.67      1.67      6.33
 Crankcase         0.00      0.00      0.00      0.00      0.00                                    0.00
 Refuel            1.14      3.07      3.07      3.07      3.07
 Resting           0.02      0.02      0.02      0.02      0.02                                    0.15
 ____________________________________________________________________________________________________
```